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Visual Discriminatory Ability Among Prereaders.

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The ability of 50 lower middle-class and 25 upper middle-class prereading children to discriminate between pairs of uppercase alphabet letters was tested. A set of 3x5 cards with a sample stimulus in the upper center section of each card and two alternative choice stimuli just below and to the right and left of the sample was used. The 650 total cards were divided into five sets of 130 cards. The two major subject groupings were divided into five groups each and were tested with one set of 130 cards. An analysis of variance showed that the differences between groups both within and across each major grouping were not significant at the .05 level. The range of errors per subject was from 0 to 17 on 130 items. The letter pairs significantly confused were M-N (8); M-W and S-P (5); H-A, I-J, L-J, and K-X (3); and B-X, H-X, N-X, I-L, P-R, A-X, and H-W (2). The uppercase letters with the lightest percentage of errors were in descending order: M, N, K, X, H, P, W, and I. Tables and references are included. (BS)

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VISUAL DISCRIMINATORY ABILITY AMONG PREREADERS [1]

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This study was designed to identify upper case letter pairs frequently confused by pre-reading children. Ss were required to match a stimulus letter with one of 2 response choices. Confusion appeared most frequently on letter pairs involving only straight lines. Distortions involving rotations of letters and alterations of "line to curve" may have contributed to confusion. Previous research is discussed.

For more than 40 years researchers have been concerned with the relationship between visual discrimination of letters and early reading achievement. However, few studies have dealt solely with the confusability of letters and letter pairs. Of these, only Smith's study (1928) examined the relative difficulty of all the upper-case letters of the alphabet but gave no indication of the confusability of letter pairs.

The purpose of the present study was to determine which pairs of upper-case alphabet letters were most frequently confused by prereading children and were therefore most likely to cause difficulty in initial reading instruction. The identification of confusing letters and letter pairs makes the teacher cognizant of the relative difficulty of the various letters and consequently allows her to distribute her practice accordingly. The method used was essentially the same as the one Popp (1964) used in her study of the visual discrimination of lower-case letters.

Method

Subjects. Two "waves" of children were used. Wave I consisted of 50 children, with ages from 5 years 5 months to 6 years 4 months (median age 6 years zero months), who attended a public kindergarten in a lower-middle-class community. The population of children in this school district rank at the national average on intelligence and achievement tests. Wave II consisted of 25 children, with ages from 3 years 7 months to 5 years

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6 months (median age 4 years 4 months), who attended a public nursery school supported by a leading university in an upper-middle-class community. The children of this school district rank well above the national average on national school evaluative tests. Each wave was divided into five groups, numbered 1 through 5. Wave I had 10 Ss in each group and Wave II had 5 Ss in each group, with an even distribution of chronological ages within the groups. Testing was done in April before the children had received any formal prereading instruction.

Criterion for S's selection was based on a test which required seven consecutive correct responses on a matching task using only the letters X and O. One child in each wave failed to reach this criterion within 15 cards and was replaced by another child of the same age.

Materials. A set of 3 x 5 cards was used. A sample stimulus of a capital letter was set in the upper center section of each card, with two alternative choice stimuli displayed just below and to the right and left of the sample. One of the alternative choice stimuli was identical with the sample stimulus. For a correct choice the S had to match the sample stimulus with the identical one in the alternative choice set. All three of the capital letters were in large primary print, 1/4 in. in height.

There were 25 capital letters for each of the 26 sample stimuli, to give a total of 650 cards. A Gellerman Series (Gellerman, 1933) was used to determine whether the correct letter in the alternative choice set were placed at the right or left of the sample. The Gellerman Series was also used to determine the sequence in which the cards were displayed to the S. A constraint of no more than two successive cards with the same sample stimulus was imposed.

The 650 cards were then divided into 5 sets of 130 cards. Groups 1 through 5 within a wave each received a different set of cards, but identically numbered groups in the two waves received the same set of cards. For Wave I 650 cards were discriminated 10 times and the 325 letter pairs were discriminated 20 times. For Wave II 650 cards were discriminated 5 times and the 325 letter pairs were discriminated 10 times. Each S responded to a card by pointing to the alternative choice stimuli that matched the sample stimulus. When the S made an error, the E flipped the card over and continued on to the next card. The errors were tallied by the E after the S had left the testing room. The E and S sat at a small table facing each other. Testing time per S was approximately 10 min.

Procedure. To check on the experimental control and to provide a chance distribution of errors, 13 X-O items were seeded in with the 130 cards presented to each subject (making a total of 143 discriminations per child).

Results

The variance tables for differences in error scores between the five groups of each wave are presented in Tables 1 and 2. The F value for each wave was not significant at the .05 level; the differences between groups within each wave can therefore be ignored.

Insert Tables 1 & 2 About Here

Table 3 shows the difference in error scores between waves, and Table 4 the difference in error scores between groups across the two waves. Neither of the F values was significant at the .05 level, which suggests that the differences between waves and the differences between groups across waves can also be ignored. A partial explanation for this lack of significant difference between the two waves is that Wave II children were of higher intellectual ability and from a more favorable family background than were the older Wave I children.

Insert Tables 3 & 4 About Here

Table 5 shows the number of errors made on each pair of letters by each wave. Table 6 shows the total number of letter-pair errors by both waves.

Insert Tables 5 & 6 About Here

Figure 1 is a frequency distribution of errors per letter pair for both waves. This distribution should be compared with the distributions of errors for letter pairs which the children were known to be able to discriminate (see Figure 2), in order to estimate the probability that errors were due to discriminability and not to "chance." The latter distributions were constructed from the error scores on the 65 X and 0 cards or 32 pairs (one was discarded). One or more errors were significant for Wave I while all

errors were significant for Wave II. (To facilitate readability, only those "confusions" of two or more errors are listed in Table 5 by each wave and in Table 6 for both waves.)

Insert Figure 1 & 2 About Here

For Wave I the Ss' error rate on the X and O cards was 0.46% and only 0.86 % on the letter cards. For Wave II the Ss' error rate on the X and O cards was 0% and 0.65% on the letter cards. This indicates that the experimental control was satisfactory and that the discriminatory task was not difficult for these preschool children. Collapsing the two waves, the range of errors per subject was from 0 to 17 on 130 items; 41 subjects made 0 errors and only one S made more than 7 errors.

Table 7 indicates the relative difficulty of each letter by comparing the highest percentages of errors for the present study and Smith's study (1928). No letter is common to both lists. In fact, whereas the present study found the letters X, H, and I to be among those causing the highest percentage of errors, they were not missed by any children in Smith's study. There are several alternative explanations for the differences between studies. First, Smith used an array of letters for the discrimination task whereas the present study used only letter pairs. Other minor differences in presentation may also have affected the results. Second, there may be significant differences between the Ss; Smith's study used first-grade children, the present study preschool children. Further, Smith's study was executed over 40 years ago. Third, the size and style of type used for the stimulus may have affected the studies. Fourth, the method of analysis probably differs. The data are not complete enough in the Smith study to determine how she analyzed errors.

Insert Table 7 About Here

Discussion

The exact relationship between visual discriminatory ability and reading achievement is questionable. In his review of the literature on this subject, Barrett (1965) suggested that visual discrimination of letters

and words has a higher predictive relationship to early reading achievement than does visual discrimination of geometric designs and pictures. However, conclusions as to whether discrimination of letters or discrimination of words is more closely related to first-grade reading achievement are tenuous. Results concerning the relationship of specific training or practice in visual discrimination to reading achievement are also tenuous.

The present study was designed to measure the "confusability" of upper-case alphabet letters with prereading children as a means of determining the relative difficulty of discriminating such pairs. Previous studies suggest that the ability to discriminate letter pairs must include a consideration of the distinctive features and formal similarities of letters. Gibson, Gibson, Pick, and Osser (1962) hypothesized that distinctive features of letter patterns are attended to in the discrimination of letter-like forms. They also suggested that transformations such as "reversals and rotations" (e.g. M-W) and "changes of line to curve" (e.g. C-L) are critical for letter identification. As indicated in Table 6 under "confusions", most of the error pairs were of these two types. Other errors appearing in this list were based on the exclusion and/or extension of lines (e.g. H-A, M-N). The confusability of S and P may be based, in part, on association rather than on discrimination (e.g. S. P. for salt and pepper). The question of whether training prereading children to discriminate confusable letters by significant features will have any effect on their later reading achievement still remains unanswered.

References

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Footnote

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Figure Captions

Fig. 1. Number of letter pairs receiving various numbers of total errors.

Fig. 2. Number of X-O items receiving various numbers of total errors.

Table 1

Analysis of Variance of Error Scores for Wave I

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F Value
Between groups	4	12.48	3.12	0.87
Within groups	45	160.80	3.57	

Table 2

Analysis of Variance of Error Scores for Wave II

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F Value
Between groups	4	52.64	13.16	1.16
Within groups	20	226.80	11.34	

Table 3

Analysis of Variance of Error Scores Between Waves

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F Value
Between waves	1	5.23	5.23	0.84
Within waves	73	452.72	6.20	

Table 4

Analysis of Variance of Error Scores Between Groups Across The Two Waves

Source of Variance	Degrees of Freedom	Sum of Squares	Mean Square	F Value
Between groups across waves	4	19.02	4.76	0.76
Within groups across waves	70	438.93	6.27	

Table 5

Total number of errors for Wave I		Number of Errors Made on Each Letter Pair																									Total number of errors for Wave II
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
7	A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	B	0		0	0	0	0	0	0	0	0	2	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	6
0	C	0	0		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
0	D	0	0	0		0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	3
4	E	0	0	0	0		1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4
5	F	0	0	0	0	0		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
0	G	0	0	0	0	0	0		0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
9	H	3	0	0	0	0	1	0		0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
6	I	0	0	0	0	0	0	0	0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
4	J	0	0	0	0	0	1	0	0	2		0	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4
6	K	0	0	0	0	0	0	0	1	0	0		0	0	0	0	0	1	0	0	0	0	0	0	2	0	0	8
5	L	0	0	0	0	0	0	0	0	2	1	0		0	0	0	0	0	0	0	0	0	0	0	1	0	0	3
8	M	0	0	0	0	0	0	0	0	0	0	0	0		3	0	0	0	0	0	0	0	0	3	0	0	0	7
10	N	0	0	0	0	0	0	0	1	1	0	2	0	5		0	0	0	0	0	0	0	0	0	0	0	0	4
3	O	0	0	0	0	1	0	0	0	0	0	0	1	0	1		0	1	0	0	0	0	0	0	0	0	0	2
8	P	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0		0	1	1	0	0	0	0	1	0	0	3
1	Q	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	3
3	R	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1		0	0	0	0	1	0	0	0	3
5	S	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	4	0	0		0	0	0	0	0	0	3
4	T	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0		0	0	0	0	1	1
4	U	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0		0	0	0	0	0
1	V	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	1	0	1
3	W	0	0	0	0	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0		1	0	6
6	X	2	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0		1	0	7
7	Y	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0		0	1
2	Z	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0		3

Letter Pairs Significantly Confused

Wave I: M-N 5 S-P 4 H-A 3 M-W, I-J, I-L, N-K, and X-A 2

Wave II: M-N and M-W 3 K-X, B-X, and J-L 2

Table 6

Number of Errors Made on Each Letter Pair for Both Waves

Total number of errors		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	
7	A		0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	1	A
7	B			0	0	0	0	0	0	0	0	2	0	1	0	1	0	0	1	0	0	0	0	0	0	1	1	B
2	C				0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	C
3	D					0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	D
8	E						1	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1	1	0	E
7	F							0	1	1	1	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	F
3	G								0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G
11	H									0	0	2	0	0	1	0	0	0	0	0	0	1	0	2	0	1	0	H
9	I										3	0	2	0	1	0	0	0	0	0	0	0	0	0	0	1	0	I
8	J											0	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	J
14	K												0	0	2	0	0	1	0	1	0	1	0	0	3	0	0	K
8	L													0	0	1	0	0	0	0	0	1	0	0	1	0	0	L
15	M														8	0	0	0	0	0	1	0	0	5	0	0	0	M
14	N															1	0	0	0	0	0	0	0	0	0	0	0	N
5	O																0	1	0	0	0	0	0	0	0	0	0	O
11	P																	0	2	5	0	0	0	0	1	1	0	P
4	Q																		1	0	0	0	0	0	0	0	0	Q
6	R																			0	0	0	0	1	0	0	0	R
8	S																				0	0	0	0	0	0	0	S
5	T																					0	0	0	1	1	1	T
4	U																						0	0	0	1	0	U
2	V																							0	1	0	0	V
9	W																								1	0	0	W
13	X																									1	1	X
8	Y																										0	Y
5	Z																											

Letter Pairs Significantly Confused

M-N 8 M-W and S-P 5 H-A, I-J, L-J, and K-X 3

B-X, H-X, N-X, I-L, P-R, A-X, and H-W 2

Table 7

Upper Case Letters With The Highest Percentage of Errors

Present Study		Smith (1928)	
Letter	Percentage of Error	Letter	Percentage of Error
M	02.3	Q	25.0
N	02.2	B	23.0
K	02.2	D	22.0
X	02.0	J	22.0
H	01.7	Y	22.0
P	01.7	Z	22.0
W	01.4	R	22.0
I	01.4	U	22.0

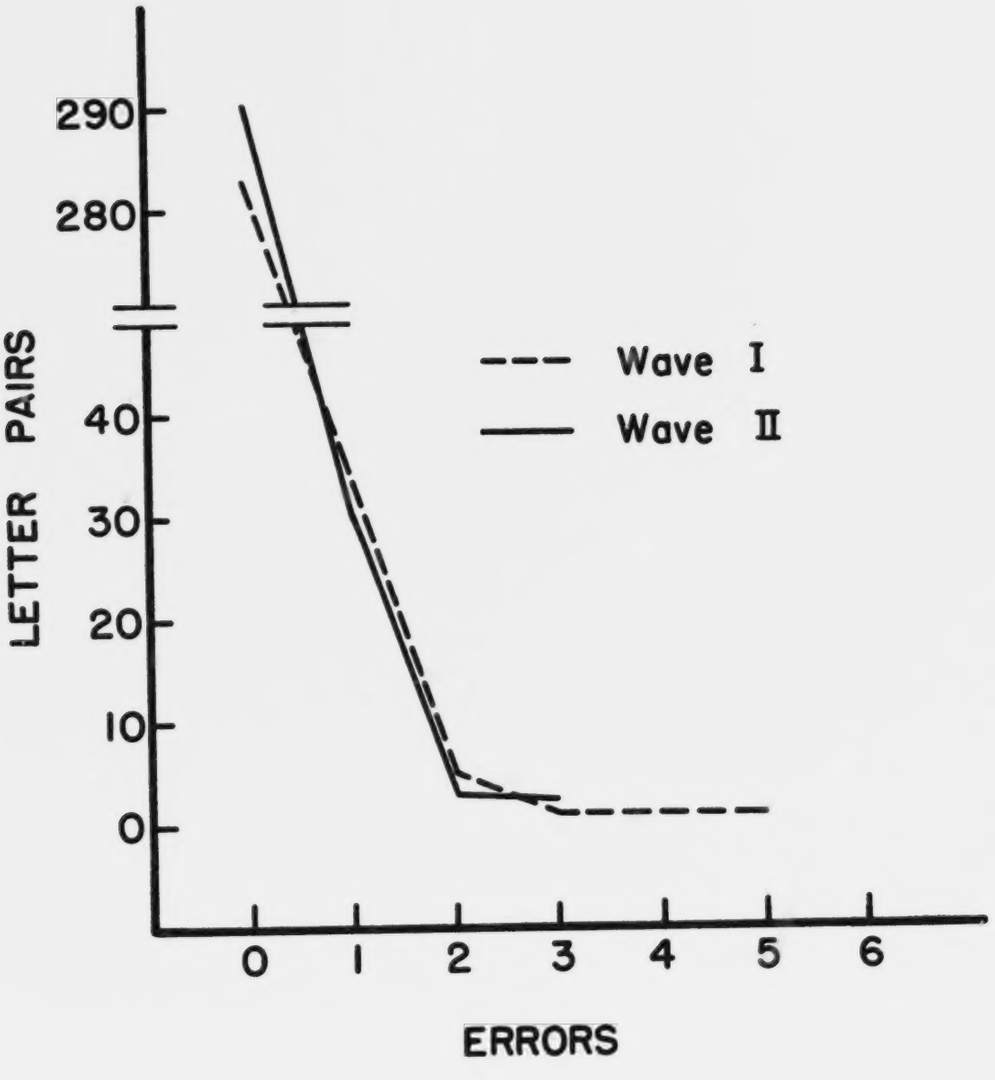
290
280
40
30
20
10
0
LETTER PAIRS
Wave I
Wave II
0
1
2
3
4
5
6
ERRORS

Figure 1

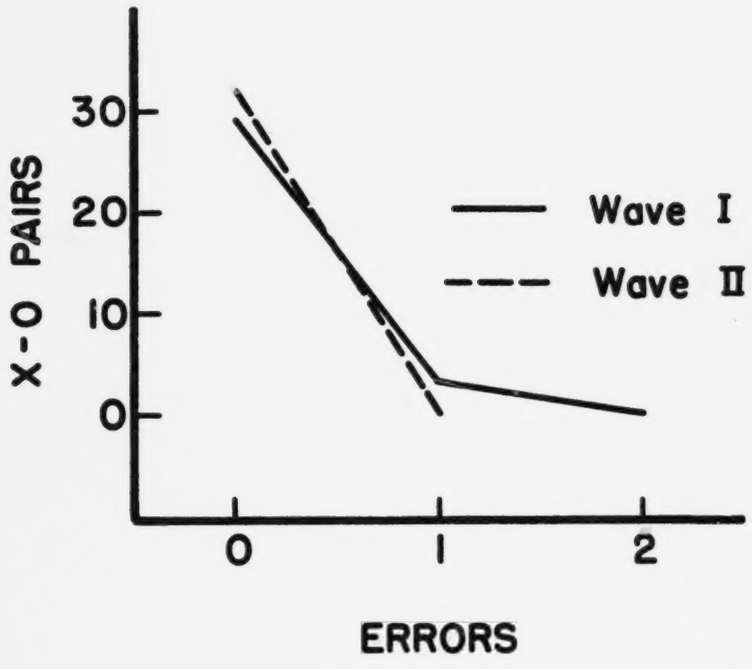

Figure 2